# U.S.ENVIRONMENTAL PROTECTION AGENCY NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY 540 S. MORRIS AVE., MONTGOMERY, AL 36115 RA228 ANALYSES

#### REPORT OF SAMPLE DELIVERY GROUP #1200002

Project:

Dimock Residential GW Site, Dimock, PA

Analysis method:

Radium-228 in Environmental Matrices

Report ID:

1200002-RA228

Report type: Date reported: Original 03/29/2012

Total pages in report:

22

#### **SAMPLES**

NAREL Sample#	Client Sample ID	Location	Matrix	Date Collected	Date Received
B2.02559T	FB19	PA:DIMOCK	WATER-DRINKING	03/05/2012	03/07/2012
B2.02560K	HW56	PA:DIMOCK	WATER-DRINKING	03/05/2012	03/07/2012
B2.02561L	HW60	PA:DIMOCK	WATER-DRINKING	03/05/2012	03/07/2012
B2.02617K	FB20	PA:DIMOCK	WATER-DRINKING	03/06/2012	03/08/2012
B2.02618L	HW61	PA:DIMOCK	WATER-DRINKING	03/06/2012	03/08/2012
B2.02619M	HW61Z	PA:DIMOCK	WATER-DRINKING	03/06/2012	03/08/2012
B2.02675W	FB21	PA:DIMOCK	WATER-DRINKING	03/08/2012	03/09/2012
B2.02676X	HW50	PA:DIMOCK	WATER-DRINKING	03/08/2012	03/09/2012

#### **EXCEPTIONS**

- 1. Packaging and shipping-No problems were observed.
- 2. Documentation-No problems were observed.
- 3. Sample preparation-No problems were encountered.
- 4. Analysis- No problems were encountered.
- 5. Holding times-No holding times were specified.

#### QUALITY CONTROL

- 1. QC samples-All QC analysis results met NAREL acceptance criteria.
- 2. Yields-All chemical yields were within acceptance limits.
- 3. Instruments-Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

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#### CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

Mary F. Wisdom
Quality Assurance Manager, NAREL

John G. Griggs, Ph.D.

Date

Director Griggs, Ph.D.

Director, Center for Environmental Radioanalytical

Laboratory Science

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#### GENERAL INFORMATION

#### SAMPLE TYPES

BLD Blind sample FBK Field blank SAM Normal sample

#### ANALYSIS QC TYPES

ANA Normal analysis
DUP Laboratory duplicate

LCS Laboratory control sample (blank spike)

MS Matrix spike

MSD Matrix spike duplicate

RBK Method blank

#### **OUALITY INDICATORS**

RPD Relative Percent Difference

%R Percent Recovery

Z Number of standard deviations by which a QC measurement differs from the expected value

#### **EVALUATION OF QC ANALYSES**

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "Z scores." A Z score is the number of standard deviations by which the QC result differs from its ideal value. The score is considered acceptable if its absolute value is not greater than 3.

The Z score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference.

The Z score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference. When the precision of paired MS/MSD analyses is evaluated, the native sample activity is subtracted from each measured value and the net concentrations are then converted to total activities before the Z score is computed.

Each standard uncertainty used to compute a Z score includes an additional fixed term to represent sources of measurement error other than counting error. This additional term is not used in the evaluation of reagent blanks.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation.

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### SDG #1200002

### **ANALYSIS SUMMARY**

Analysis Procedure:

NAREL RA-05

Title:

Radium-228 in Environmental Matrices

NAREL Sample #	QC Type	Preparation Procedure	Date Completed	Assay Batch#	QC Batch#
B2.02559T		NAREL RA-03	03/28/2012	0015846U	0008595R
B2.02560K		NAREL RA-03	03/28/2012	0015846U	0008595R
B2.02561L	ł	NAREL RA-03	03/28/2012	0015846U	0008595R
B2.02617K		NAREL RA-03	03/29/2012	0015847V	0008595R
B2.02618L		NAREL RA-03	03/29/2012	0015847V	0008595R
B2.02618L	DUP	NAREL RA-03	03/29/2012	0015847V	0008595R
B2.02619M		NAREL RA-03	03/29/2012	0015847V	0008595R
B2.02675W	ŀ	NAREL RA-03	03/28/2012	0015846U	0008595R
B2.02676X		NAREL RA-03	03/28/2012	0015846U	0008595R
B2.02676X	MS	NAREL RA-03	03/28/2012	0015846U	0008595R
LCS-00634434X *	LCS	NAREL RA-03	03/28/2012	0015846U	0008595R
RBK-00634433W *	RBK	NAREL RA-03	03/29/2012	0015847V	0008595R
STD-00634437A *	STD	NAREL RA-03	03/28/2012	0015846U	0008595R
STD-00634438B *	STD	NAREL RA-03	03/29/2012	0015847V	0008595R

<sup>\*</sup> Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

# PREPARATION METHOD(S) USED

Procedure ID	Title
NAREL RA-03	Preparing Water Samples for Ra-226 and Ra-228 Analysis

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### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #:

B2.02559T

WATER-DRINKING

QC batch #: Assay batch #: 0008595R

Matrix: Sample type:

SAM

Prep procedure:

0015846U NAREL RA-03

Amount analyzed:

1.000e+00 L

Analysis procedure:

NAREL RA-05

Dry/wet weight: Ash/dry weight: N/A

Analyst: QC type:

VHANA

Sample description:

N/A N/A

Comment:

Aqueous

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/28/2012 11:12	100.0	QA1A	GVJ

#### ANALYTICAL RESULTS

	<u> </u>	±2 σ			
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	-8.33e-02	4.4e-01	7.9e-01	PCI/L	03/26/2012 13:50 CDT

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#### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #: Matrix:

B2.02560K WATER-DRINKING QC batch #: Assay batch #: 0008595R

Sample type:

SAM

0015846U

Amount analyzed:

1.000e+00 L

Prep procedure: Analysis procedure: NAREL RA-03 NAREL RA-05

Dry/wet weight: Ash/dry weight:

N/A N/A

Analyst: QC type:

VH ANA

Sample description: Comment:

N/A N/A

#### COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
03/28/2012 11:12	100.0	QA1B	GVJ

#### ANALYTICAL RESULTS

		± 2 σ			
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	1.13e-01	4.5e-01	7.7e-01	PCI/L	03/26/2012 13:50 CDT

Report: 1200002-RA228 -6-Original

#### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #:

Comment:

B2.02561L

QC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015846U

Sample type: Amount analyzed: SAM

Prep procedure:
Analysis procedure:

NAREL RA-03 NAREL RA-05

Dry/wet weight:

1.000e+00 L N/A N/A

Analyst: QC type: VH ANA

Ash/dry weight: Sample description: N/A N/A N/A

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/28/2012 11:12	100.0	QA1C	GVJ

#### ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Date
Ra228	4.29e-01	5.0e-01	8.1e-01	PCI/L	03/26/2012 13:50 CDT

Report: 1200002-RA228 - 7 - Original

#### SDG #1200002

### SAMPLE ANALYSIS REPORT

Sample #:

B2.02617K

QC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015847V

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed:

1.000e+00 L

Analysis procedure:

NAREL RA-05

Dry/wet weight:

N/A

Analyst:

NAKEL KA-VH

Ash/dry weight:

N/A N/A QC type:

ANA

Sample description: Comment: N/A Aqueous

#### **COUNTING INFORMATION**

	Date and time	Duration (min)	Detector ID	Operator
ſ	03/29/2012 10:48	100.0	QA1A	GVJ

#### ANALYTICAL RESULTS

Analyte	Activity	±2 σ Uncertainty	MDC	Unit	Date
Ra228	4.82e-01	4.8e-01	7.7e-01	PCI/L	03/26/2012 13:50 CDT

Report: 1200002-RA228 - 8 - Original

### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #:

B2.02618L

QC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015847V

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed:

5.000e-01 L

Analysis procedure:

NAREL RA-05

Dry/wet weight:

N/A

Analyst:

VH

Ash/dry weight:

N/A N/A QC type:

ANA

Sample description: Comment:

N/A

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/29/2012 10:48	100.0	QA1C	GVJ

#### ANALYTICAL RESULTS

		±2σ			
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	-7.76e-01	8.4e-01	1.6e+00	PCI/L	03/26/2012 13:50 CDT

Report: 1200002-RA228 -9-Original

# SDG #1200002

### SAMPLE ANALYSIS REPORT

Sample #:

Comment:

B2.02618L

QC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015847V

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed:

5.000e-01 L

Analysis procedure:

NAREL RA-05

Dry/wet weight:

N/A

Analyst: QC type:

VH DUP

Ash/dry weight: Sample description: N/A N/A

N/A

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/29/2012 10:48	100.0	QA1D	GVJ

#### ANALYTICAL RESULTS

		± 2 σ			
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	-2.78e-01	8.1e-01	1.5e+00	PCI/L	03/26/2012 13:50 CDT

Original Report: 1200002-RA228 - 10 -

### SDG #1200002

# SAMPLE ANALYSIS REPORT

Sample #:

B2.02619M

OC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015847V

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed:

1.000e+00 L

Dry/wet weight:

Analysis procedure:

NAREL RA-05

N/A

Analyst: QC type: VH ANA

Ash/dry weight: Sample description: N/A N/A

Comment:

N/A

#### COUNTING INFORMATION

Da	te and time	Duration (min)	Detector ID	Operator
03/29	9/2012 10:48	100.0	QA2B	GVJ

#### ANALYTICAL RESULTS

		±2σ			
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	5.65e-02	4.0e-01	7.0e-01	PCI/L	03/26/2012 13:50 CDT

Original Report: 1200002-RA228 - 11 -

### SDG #1200002

### SAMPLE ANALYSIS REPORT

Sample #:

B2.02675W

OC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015846U

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed: Dry/wet weight:

1.000e+00 L

Analysis procedure:

NAREL RA-05

Ash/dry weight:

N/A N/A Analyst: QC type: VHANA

Sample description: Comment:

N/A Aqueous

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/28/2012 11:12	100.0	QA1D	GVJ

#### ANALYTICAL RESULTS

		±2 σ			
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	-2.55e-01	4.0e-01	7.5e-01	PCI/L	03/26/2012 13:50 CDT

Original Report: 1200002-RA228 - 12 -

#### SDG #1200002

### SAMPLE ANALYSIS REPORT

Sample #:

B2.02676X

QC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015846U

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed:

5.000e-01 L

Analysis procedure:

NAREL RA-05

Dry/wet weight: Ash/dry weight:

N/A

Analyst: QC type:

VH ANA

Sample description: Comment:

N/A N/A

N/A

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/28/2012 11:12	100.0	QA2A	GVJ

#### ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Date
Ra228	-1.76e-01	8.0e-01	1.4e+00	PCI/L	03/26/2012 13:50 CDT

Report: 1200002-RA228 Original - 13 -

#### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #:

B2.02676X

QC batch #:

0008595R

Matrix:

WATER-DRINKING

Assay batch #:

0015846U

Sample type:

SAM

Prep procedure:

NAREL RA-03

Amount analyzed:

5.000e-01 L

Analysis procedure:

NAREL RA-05

Dry/wet weight:

N/A

Analyst:

VH

Ash/dry weight:

N/A N/A QC type:

MS

Sample description: Comment:

N/A

#### COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
03/28/2012 11:12	100.0	QA2B	GVJ

#### ANALYTICAL RESULTS

		±2 σ			<u> </u>
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	2.94e+01	3.0e+00	1.4e÷00	PCI/L	03/26/2012 13:50 CDT

Report: 1200002-RA228 - 14 -Original

#### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #:

Comment:

LCS-00634434X

QC batch #:

0008595R

Matrix:

N/A

Assay batch #:

0015846U

Sample type:

N/A

Prep procedure:

NAREL RA-03

Amount analyzed:

1.000e+00 SAMP N/A

Analysis procedure:

NAREL RA-05

Dry/wet weight: Ash/dry weight:

N/A

Analyst: QC type:

VHLCS

Sample description:

N/A N/A

#### **COUNTING INFORMATION**

	Date and time	Duration (min)	Detector ID	Operator
ſ	03/28/2012 11:12	100.0	QA2C	GVJ

### ANALYTICAL RESULTS

		± 2 σ	_		
Analyte	Activity	Uncertainty	MDC	Unit	Date
Ra228	1.30e+01	1.4e+00	7.0e-01	PCI	03/26/2012 13:50 CDT

Original Report: 1200002-RA228 - 15 -

#### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #: Matrix:

RBK-00634433W N/A

QC batch #: Assay batch #: 0008595R 0015847V

Sample type:

N/A

Prep procedure:

NAREL RA-03

Amount analyzed:

1.000e+00 SAMP N/A

Analysis procedure:

NAREL RA-05

Dry/wet weight: Ash/dry weight:

N/A N/A

Analyst: QC type: VH RBK

Sample description:

Comment: N/A

#### **COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
03/29/2012 10:48	100.0	QA2C	GVJ

#### ANALYTICAL RESULTS

			±2σ			
ĺ	Analyte	Activity	Uncertainty	MDC	Unit	Date
	Ra228	9.80e-02	4.0e-01	6.9e-01	PCI	03/26/2012 13:50 CDT

Original Report: 1200002-RA228 - 16 -

# SDG #1200002

### SAMPLE ANALYSIS REPORT

Sample #:

STD-00634437A

QC batch #:

0008595R

Matrix:

N/A

Assay batch #:

0015846U

Sample type:

N/A

Prep procedure:

NAREL RA-03

Amount analyzed: Dry/wet weight:

1.000e+00 ML N/A

Analysis procedure:

NAREL RA-05

Ash/dry weight:

N/A N/A

Analyst: QC type: VH STD

Sample description: Comment:

N/A

# **COUNTING INFORMATION**

ĺ	Date and time	Duration (min)	Detector ID	Operator
ſ	03/28/2012 11:12	100.0	QÃ2D	GVJ

#### ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Date
Ra228	8.28e+01	5.1e+00		%	03/26/2012 13:50 CDT

Original Report: 1200002-RA228 - 17 -

#### SDG #1200002

#### SAMPLE ANALYSIS REPORT

Sample #:

STD-00634438B

QC batch #:

0008595R

Matrix:

N/A

Assay batch #:

0015847V

Sample type:

N/A

Prep procedure:

NAREL RA-03

Amount analyzed:

1.000e+00 ML

Analysis procedure:

Dry/wet weight:

N/A

Analyst:

NAREL RA-05

Ash/dry weight:

N/A N/A QC type:

VH STD

Sample description: Comment:

N/A

#### COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
03/29/2012 10:48	100.0	QA2D	GVJ

#### ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Date
Ra228	7.81e+01	4.8e+00		%	03/26/2012 13:50 CDT

Report: 1200002-RA228 - 18 -Original

# SDG 1200002

# **QC BATCH SUMMARY**

QC batch #:

0008595R

Preparation procedure:
Analysis procedure:

NAREL RA-03 NAREL RA-05

	QC			
NAREL Sample #	Туре	Yield (%)	$\pm 2 \sigma$ Uncertainty (%)	Analyst
B2.02559T		N/A		VH
B2.02560K	1	N/A	}	VH
B2.02561L		N/A		VH
B2.02617K		N/A		VH
B2.02618L		N/A		VH
B2.02618L	DUP	N/A	]	VH
B2.02619M		N/A		VH
B2.02675W		N/A		VH
B2.02676X		N/A		VH
B2.02676X	MS	N/A		VH
LCS-00634434X *	LCS	N/A		VH
RBK-00634433W *	RBK	N/A		VH
STD-00634437A *	STD	N/A		VH
STD-00634438B *	STD	N/A		VH

<sup>\*</sup> Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

### SDG 1200002

### ASSAY BATCH SUMMARY

#### EXTERNAL STANDARD RECOVERY

Assay Batch	Analysis #	Analyte	Standard Concentration	Reference Date	Recovery	± 2 σ Uncertainty
0015846U	00634437A	RA228	9.07e+01 PCI/ML	04/19/2010	82.84 %	5.05 %
0015847V	00634438B	RA228	9.07e+01 PCI/ML	04/19/2010	78.12 %	4.75 %

#### SAMPLES ANALYZED

NAREL Sample #	QC Type	Aliquot Size	Completion Date	Prep Batch
B2.02559T	_	1.00e+00 L	03/28/2012	0015846U
B2.02560K		1.00e+00 L	03/28/2012	0015846U
B2.02561L		1.00e+00 L	03/28/2012	0015846U
B2.02617K		1.00e+00 L	03/29/2012	0015847V
B2.02618L		5.00e-01 L	03/29/2012	0015847V
B2.02618L	DUP	5.00e-01 L	03/29/2012	0015847V
B2.02619M		1.00e+00 L	03/29/2012	0015847V
B2.02675W		1.00e+00 L	03/28/2012	0015846U
B2.02676X		5.00e-01 L	03/28/2012	0015846U
B2.02676X	MS	5.00e-01 L	03/28/2012	0015846U
LCS-00634434X *	LCS	1.00e+00 SAMP	03/28/2012	0015846U
RBK-00634433W *	RBK	1.00e+00 SAMP	03/29/2012	0015847V
STD-00634437A *	STD	1.00e+00 ML	03/28/2012	0015846U
STD-00634438B *	STD	1.00e÷00 ML	03/29/2012	0015847V

Samples marked with an asterisk (\*) are not in SDG #1200002 but were analyzed with it for QC purposes

Report: 1200002-RA228 20 Original

# National Air and Radiation Environmental Laboratory QC Batch Report

QC Batch #: 0008595R

Analytical Method: NAREL RA-05

#### METHOD BLANKS (PCI)

Sample ID	Nuclide	Activity ± 2σ	Prep Date	Flags
00634433W	RA228	9.80e-02 ± 4.0e-01	2012-03-26	OK

#### LABORATORY DUPLICATES (PCI/L)

Sample ID	Nuclide	Original ± 2σ	Duplicate ± 2σ	RPD	Z
B2.02618L	RA228	-7.76e-01 ± 8.4e-01	-2.78e-01 ± 8.1e-01	0.00	0.85 OK

#### MATRIX SPIKES (PCI/L)

Sample ID	Nuclide	Amt Added ± 2 $\sigma$	Native ± 2σ	Measured ± 2σ	%R Z	
B2.02676X	RA228	2.95e+01 ± 4.2%	-1.76e-01 ± 8.0e-01	2.94e+01 ± 3.0e+00	100.47 0.06 0	K

#### LAB CONTROL SAMPLES (PCI)

Sample ID	Nuclide	Amt Added ± 2σ	Measured ± 2σ	%R	Z				
00634434X	RA228	1.47e+01 ± 4.2% /	1.30e+01 ± 1.4e+00	88.28	-1.65 OK				
Analyst: Hillinda 1 Hebet 3/29/12									
OA Officer:	Herbert,	Velinda MC	3/2	29/12					

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